

Evaluation of The Kummer Sanitary Landfill

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MINN. POLLUTION
CONTROL AGENCY

I hereby certify that this report was prepared by me and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.



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Reg. No. 8734

Date: September 19, 1980

EVALUATION OF THE KUMMER SANITARY LANDFILL

INTRODUCTION

In early 1980, the Minnesota Pollution Control Agency and Jon Kummer, operator of the Kummer Sanitary Landfill, entered into a stipulation agreement concerning the permit to operate the site. Included in this agreement were requirements concerning site design, groundwater conditions, and methods of operation. This report is intended to provide information concerning the above items. Specifically, the MPCA requirements are:

- a. A map showing current groundwater contours at and adjacent to the landfill.
- b. A description of the soils beneath the subject landfill and surrounding area.
- c. A map showing the locations and depths of all existing and proposed monitoring wells to be used for the facility's groundwater monitoring system. All proposed monitoring well locations and depths shall be selected to detect and measure possible vertical and horizontal migration of leachate from the subject landfill.
- d. A report identifying the present and anticipated future extent of leachate generation and migration in the area surrounding the subject landfill.
- e. A report outlining proposed mitigative measures necessary to correct and/or prevent pollution of surface and groundwater in the area surrounding the subject landfill.
- f. A plan outlining time schedules for placement, grading, and seeding of final soil cover on all completed areas of the subject facility. Additionally, the plan shall identify and quantify the source(s) of available daily, intermediate, and final soil cover necessary to achieve complete complete compliance with Minn. Rule SW-6(2)(d), (e), and (z).

Information used in the study included topography of the existing site based on aerial surveys by the City of Bemidji. Nine shallow wells (including the existing monitoring wells) were used for measuring groundwater levels.

General data and information that is the basis for much of this report was obtained from the following agencies:

Beltrami County
Minnesota Pollution Control Agency
Minnesota Geological Survey
U. S. Department of the Interior, Geological Survey
U. S. Department of Agriculture, Soil Conservation Service

SOILS AND GEOLOGY

The landfill site is located in the NE 1/4 of Section 32, T. 147 N., R. 33 W., Beltrami County, Minnesota. It is just adjacent to the north developed limits of the City of Bemidji, Minnesota. Adjacent land uses are hay or pastureland to the east and west, wooded areas to the south, and an extensive bog to the north. Figure 1 shows the landfill location.

The topography of the area is gently rolling to nearly flat. Drainage appears to be rather well defined with only scattered areas with landlocked depressions. It appears that prior to the site being disturbed for filling operations, the site topography was similar to areas to the east and west.

Surface drainage of the area is generally to the east towards Lake Bemidji.

The surficial soils of the landfill area are fine sands resulting from alluvial deposition during the latest glaciation of the area. Oakes and Bidwell (1968) describe the surficial soils as "outwash sand". The large bog area to the north is the result of shallow lake peat deposits that have occurred since the last glaciation ⁱⁿ is a large (area-wise) depression in the outwash plain.

Site soil borings have not been taken at the site except for shallow hand auger borings to place groundwater elevation measuring wells. These shallow wells showed fine sand to the water table. In Section 33, several

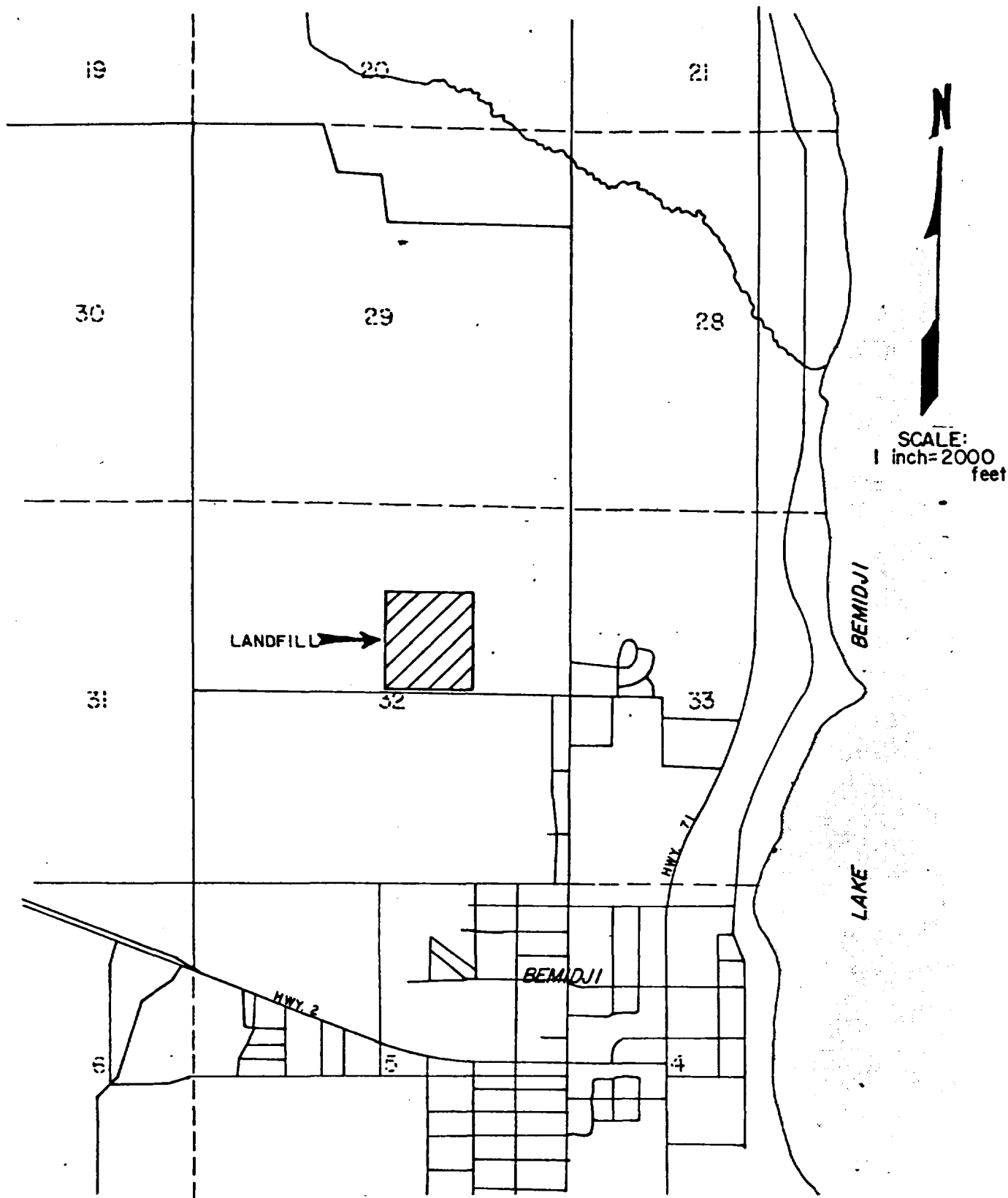


FIGURE 1
LOCATION MAP
KUMMER SANITARY LANDFILL

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domestic wells have been installed for which logs were available at the Minnesota Geological Survey. These wells show about 40 to 45 feet of sand located over a "clay" layer of up to 20 feet in thickness. Beneath the clay layer are additional strata of sands and probably less permeable material.

About 1/4 mile to the southwest of the landfill, the Bemidji Community Hospital has recently been constructed. Borings taken for hospital construction extended to maximum depths of 42 feet. The borings show medium to fine grained sands with a little gravel throughout the boring depth except for a thin layer of silty clay at about 30 feet. Soil conditions at these hospital borings should be reasonably comparable to those at the landfill site. The topography, surface soil types, and mechanics of deposition are similar.

Bedrock in the area is at a depth of from 400 to 500 feet based on information inferred from Oakes and Bidwell (1968). The uppermost bedrock formation at that depth is either Cretaceous shale and sandstone (Oakes and Bidwell, 1968) or Precambrian intrusive rocks (Sims, 1970).

GROUNDWATER

Groundwater use in the Bemidji area is limited to the unconsolidated surficial soils above bedrock. The bedrock formations are not considered to yield water in sufficient quantities for domestic or municipal use. For example, the City of Bemidji wells located southerly about 1/2 miles are from 83 to 208 feet in depth (Oakes and Bidwell, 1968) and are all finished in the surficial drift.

The well logs for domestic wells located near to the landfill show depths of less than 100 feet for those on file at the Minnesota Geological Survey.

Figure 2 shows a summary of groundwater elevation readings at the nine monitoring points considered during the landfill study. Because of varying amounts of rainfall during 1980, it is necessary that levels over an extended time period be considered. Figure 2 also shows probable surficial groundwater contours based on the measurements.

The data indicates that for the study period, a very gradual groundwater gradient exists to the northeast and east. To the north of the site, the large bog area is likely the control for groundwater levels in the north part of the site. The bog is ditched so that water levels are probably maintained fairly stable. The water level in the bog will normally be the lowest probable groundwater level with levels at the site usually being higher except during periods of extreme drought. This can be seen by comparing water levels at Wells "E" and "H" with levels at well "G". Well "G" is just adjacent to the bog and should represent bog water levels. It can be seen that the levels at "E" and "H" are slightly higher and therefore a gradient should exist to the north towards the bog.

The sandy nature of the soils at the ground surface in the area will result in measurable quite rapid changes in groundwater levels within short time periods. For example, levels in Well "E" changed 1.7 feet during the 3 1/2 month study period. Changes at other wells were less possibly due to higher evapotranspiration values outside of the landfill.

MECHANICS OF GROUNDWATER FLOW AND LEACHATE GENERATION

Movement of water into, through, and from the soil and bedrock can be explained in terms of a balanced system. In other words, over an extended period, inflow to the soil and bedrock must equal outflow. Imbalances during the short term will result in a change in storage in the soil and rock (as indicated by rise or fall in groundwater levels).

The soil at the landfill site has been previously described as alluvial sands overlaying layers of finer silt and clay alluvial soils. Bedrock exists at great depth and is not considered a viable aquifer. For the purposes of this analysis, we have assumed that permeabilities of the underlying bedrock are much lower than that of the upper sands. Interflow between the bedrock and the unconsolidated soils was assumed to be negligible.

Water enters the soil groundwater system as infiltration and by lateral movement of groundwater into a specific area. Outflow will be either vertically to other waterbearing soil layers or horizontally to surface seepage outlets. The probability that the bog area to the north of the landfill is a seepage outlet was previously discussed.

Landfill leachate or water that is contaminated by passing through refuse will be generated from the base of a landfill. Normally, it is a function of the amount of water that can enter at the top of the landfill as infiltration. When the landfill reaches field capacity or saturation, the amount of leachate generated will be about equal to the amount of water entering as infiltration.

The climate of northwestern Minnesota is such that landfills, unless of special design, may generate leachate to the groundwater system. Oakes and Bidwell (1968) indicate that the average annual rainfall is about 22.0 inches (based on 61 years of record). The water falling on the landfill will be used in several ways according to the following equation:

$$P - R - ET - S = I$$

Where:

P = Precipitation. Annual average of 22.0 inches

R = Runoff. At present, little runoff is likely generated from the landfill site except during the

spring snowmelt event. The cover soils are very granular and slopes do not drain the site. There are many landlocked areas on the top of the site. As a very rough estimate, we have estimated a site runoff of about 2.0 inches per year.

- ET = Evapotranspiration. This is water loss due to direct evaporation or use by plants. The amount of evapotranspiration depends in large degree on the adequacy of vegetation on the site. From two prior landfill studies in western and northwestern Minnesota, we estimate that evapotranspiration could range from 11 to 24 inches per year. Oakes and Bidwell (1968) estimate that the overall evapotranspiration for the upper Mississippi River watershed on the average is 19.98 inches per year.
- S = Change in Storage. For long term or steady state conditions, there would be essentially no change in storage.
- I = Infiltration. Solving the above equation would give the amount of infiltration that could occur at the site.

The present site is characterized by poorly defined drainage and a general lack of established vegetation on the landfill surface. This will result in lower values for runoff and evapotranspiration. If we assume an average runoff of 2.0 inches per year, then infiltration could be from zero to 9.0 inches per year depending on evapotranspiration values.

It is apparent that revisions in site design to maximize runoff and evapotranspiration will greatly reduce infiltration amounts. For the average year conditions, it might be possible to eliminate infiltration into the fill. In a following section, recommendations are made concerning revisions to the site design that will maximize runoff and evapotranspiration amounts.

As shown in Figure 2, groundwater from the landfill will move in an easterly and northeasterly direction. Any leachate entering the groundwater system will migrate from the site in those directions. Also, there may be a vertical component to the groundwater flow with water moving downward to deeper alluvial soil layers. In any event, there would be considerable dispersion resulting in some downward flow.

WATER QUALITY

Monitoring wells presently used for the site are located at Wells "C" and "H" and at a domestic water supply well at the Kummer home. Based on the groundwater contours in Figure 2, Well "C" and the house well are down-gradient from the landfill. Well "H" is upgradient and functions as a background well.

The following table shows results for groundwater quality tests that were performed in 1978 for the three wells.

Parameter	Unit	Well "H" Upstream		Well "C" Downstream		Kummer House Well	
		6/20/78	8/10/78	6/20/78	8/10/78	6/20/78	8/10/78
Test Date		6/20/78	8/10/78	6/20/78	8/10/78	6/20/78	8/10/78
pH	-	7.3	7.6	6.5	7.4	7.4	7.6
Total Hardness as CaCO ₃	mg/l	170	201	630	560	300	300
Chloride	mg/l	0.5	0.6	45	28	6.1	8.7
Manganese	ug/l	*20	*20	180	1400	6.8	*20
Iron	ug/l	200	110	1400	500	130	*50
Specific Conductance	**	340	380	1100	980	540	580
COD	mg/l	*5	6	35	27	7	6
Zinc	ug/l	140	160	4500	2300	140	580

* Less Than

** Units are umhos/cm at 25° C.

The parameters selected were used because they were common for both test dates. Well "C" obviously has elevated values indicating the probable presence of leachate. It is downgradient from the oldest part of the fill. While the house well is downgradient from the fill, little landfilling has been done in the south half of the site in 1978. Therefore, it is likely that no refuse was in place up-gradient at that time.

REFUSE GENERATION

As we previously indicated, the Kummer Sanitary Landfill has operated for several years generally receiving refuse from the City of Bemidji and several smaller towns in the Beltrami County area. The landfill operation is allied with Mr. Kummer's hauling business. Mr. Kummer estimates that the present refuse volume (in truck) received at the landfill is from 3,000 to 4,000 cubic yards per month. An average in-truck density of 400 pounds per cubic yards was estimated for this report for the combination of loose and packer truck loads.

LANDFILL CAPACITY AND REMAINING LIFE

Figure 3 shows recommended final contours for the Kummer Landfill based on design considerations discussed in the following sections. Based on these contours, we estimate that about 250,000 cubic yards of air space volume remains at the site. For the above estimated 3,000 to 4,000 cubic yards per month (the average of 3,500 cubic yards used) and a 5 percent per year growth rate, the remaining life of the site should be about 9 1/2 years. Inplace landfill refuse density was assumed to be 800 pounds per air space cubic yard.

There are limited quantities of cover available at the landfill site. Figure 3 shows a possible cover borrow area just to the north of the landfill. This area could be excavated to an elevation of about

1362 or above the water table. We estimate that about 75,000 cubic yards of cover could be removed from this area. If a 4 to 1 ratio of cover to refuse is assumed, there should be more than enough material in this area to complete the landfill to the grades shown.

RECOMMENDED CHANGES TO LANDFILL PLAN

Revised Final Contours

Previously problems of excessive infiltration due to final grades were discussed. Figure 3 shows proposed final contours for the site. Minimum site grades are at 2 percent and maximum grades are 4 to 1. The grades were set based on present grades at the perimeter of the landfill projected towards the center of the site at 2 percent.

These grades should eliminate the present landlocked pockets on the site where water can collect and infiltrate. Also, runoff will be encouraged particularly during the spring snowmelt event when the underlying soil is frozen. Increasing the amount of runoff will definitely decrease infiltration into the landfill.

Improvement of Final Cover

The above grading changes will increase runoff. An additional measure that will increase runoff is the provision for less permeable soil as part of the final landfill cover. A brief review of soils available in the Bemidji area indicates that little if any "clay" soils are available within a reasonable haul distance from the site. We recommend that locally available organic soils be blended with the on-site sandy topsoil for the final cover. This could possibly reduce the cover permeability but also would have the effect of providing good soil conditions for growth of vegetation.

In the previous discussion on the relation between precipitation, runoff, evapotranspiration, and infiltration, it was apparent that the encouragement of plant growth in the cover soil would have the effect of reducing infiltration. Using the organic soils blended with sands for more than six inches of the final cover (six inches is the minimum topsoil required by the MPCA) should upgrade the site in terms of plant growth.

Should any silts, clays, or other less permeable soils become available, they should definitely be reserved for use in the final cover.

Proper seed mixtures for the final turf cover could best be determined through agencies such as the University of Minnesota Agricultural Extension Department or the Soil Conservation Service.

Staged Site Completion

Figure 4 shows possible staging for the remaining filling of the site. The proposed final contours change the type of operation at the Kummer Landfill from a trench and cover site to an area fill operation. This will require some changes in detailed landfill procedure including the following:

- a. Vertical control must be established in the area fill locations so that plan grades are not exceeded and slopes meeting plans are constructed. We recommend that permanent poles (such as telephone poles) be placed at the fill area so that operators can at all times see the desired grades marked on the poles.
- b. Provision must be made for lower sheltered areas where refuse can be placed during periods of high winds. The present trench and cover areas near the landfill office could be used for these periods.
- c. As soon as areas are completed to final grades, final cover should be placed and vegetative growth established. This should be a

continuing operation and not only when a particular stage shown in Figure 4 is completed.

The staging sequence shown in Figure 4 could be altered. The important aspect of staging is the need to begin covering the northerly part of the site. From the grades shown, it is possible to complete much of this area with only one lift of refuse. Therefore, the process of final cover placement could start in the near future.

ADEQUACY OF THE MONITORING SYSTEM

Historically, monitoring at the site has included sampling at well "C", "H", and the well for the Kummer house located to the southeast of the landfill. These wells are all shallow and just penetrate the uppermost groundwater. They are all driven sand points.

The previous groundwater discussion indicated that the surficial groundwater gradient is to the east and northeast. Based on this gradient, we recommend the following overall monitoring system for the site.

- a. Well "H" should be retained as a background well for the site.
It appears to be up-gradient from the site.
- b. Well "C" and the Kummer house well should be retained as downstream monitoring wells in the uppermost groundwater.
- c. In the area of well "C", a deeper well should be installed to measure water quality in strata used by nearby residences for potable water supply. We recommend that the depth of this well be about 50 feet.

Implementation of a program of staged completion and placement of final cover should result in a decrease in leachate generation. However, if tests of samples taken at the downgradient wells show unacceptable levels of

leachate in the groundwater, then added wells should be placed to the east of wells "C" and the house well. Such wells would provide a measure of the attenuation that would be taking place as the groundwater moves laterally through the fine sandy soils.

Sampling and testing of groundwater at the four monitoring wells proposed above should be done on a quarterly basis.

SUMMARY

The Kummer Sanitary Landfill is located in an area of sandy alluvial soils. Because of the nature of the soils, irregular landfill surface grading, and lack of vegetation, infiltration rates into the landfill are likely on the order of from zero to 9 inches per year at present.

Figure 3 shows a revised site plan for the Kummer Landfill. The grades shown are intended to promote runoff from the completed site. A staging plan is also proposed. This will result in completing areas of the site to final grades and placement of final cover soils during the life of the fill rather than only at completion. Early establishment of adequate turf cover will also reduce infiltration into the site.

The three monitoring wells now used should be retained. In addition, a deeper well (about 50 feet in depth) should be placed near Well "C" to detect possible vertical movement of groundwater in the landfill area.